Genetics Through the Eyes of Tomorrow

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Overview

This module is about using other media to teach genetics. The books assigned are *Brave New World* by Aldous Huxley and *Beyond This Horizon* by Robert A. Heinlein. They will also view the movie *Gattaca* in short segments. Since this is written for high school science classes there are several adaptations that can be used. The unit contains writing so that students can improve their writing as well as their creative and critical thinking. They need to learn how to broaden their horizons and look at things in a more global way than just what their individual lives cover. Even though many of today's students are video and technological junkies, they still often live in limited circumstances in which they need to learn how to explore the world so that they can take their place in society and do the best they can when they enter young adulthood.

Rationale

This unit deals with genetic engineering of the human body in the area of cloning and genetic manipulation. There are several concepts that need to be addressed. One is cloning which is used as a term relating to the research when an exact copy of a gene, cell or organism is created.[1] To understand genetics, the students need to understand that the gene is the hereditary unit that is made up of a sequence of DNA which when located in a specific place determines a specific characteristic or trait. Mutation is part of the process by which nature deals with changes in its genetic pool.[2] Another important concept is the organism, a form of life that can be an animal or a bacteria or a plant. It can be made up of cells and organs that are combined to work together to carry out the various activities of life. Finally, it is necessary to know that the cell is the smallest basic unit that makes up living things. It is made up of the nuclei and several different parts such as the mitochondria that is the energy source of the cell. DNA material is included.[3]

Today there are several ongoing debates about the pros and cons of cloning. Dr. Patrick Dixon is the source often quoted when genetic engineering and cloning are mentioned.

He is considered a futurist and one of the top 20 business thinkers today. A futurist is a person who has "a belief that the meaning of life and one's personal fulfillment lie in the future and not in the present or past." It was "an artistic movement originating in Italy around 1910 whose aim was to express the energetic, dynamic and violent quality of contemporary life, especially as embodied in the motion and force of modern machinery" and "someone who predicts the future."[4] He studied at King's College and Cambridge and became a physician. His specialty is care of the dying especially for those who have AIDS. He launched an AIDS charity called ACET that has now spread to many countries. He is recognized as a speaker and has contributed to radio, TV and other sources of media information. He has published more than 12 books and many articles. Some of his articles mentioned are "Designer Babies"[5] and the "Future of Human Cloning"[6].

Dixon is the author of *Futurewise* where he stated that today's technology for cloning is risky. He argues that adults will age, but a newborn baby clone may have genes that are 30 years old when cloned from a gene of an adult. Animal cloning still produces many abnormalities.

In 2008, the popular TV series *Stargate SG1* had an episode that dealt with cloning. A major character, Colonel Jack O'Neil, was kidnapped and cloned. His clone did not develop properly and stayed as a child. When Star Gate Command found out that his child was a clone, they also discovered that he was dying. A genetic mutation had developed when the clone was formed that would, in the end, kill him. Although this was a science fiction plot, it is interesting to note that it supports that which current science has criticized about cloning. There are, also, emotional risks such as knowing that the mother is the sister of the clone or the grandmother is the mother of the clone. The father may have problems with his child growing up to become the 18 year old that he fell in love with and married even though she is now his cloned daughter. Another problem could be that powerful leaders could misuse the technology by using it for their own purposes.

Stem cell research is another hot topic. Since stem cells are not designated as specific cells, ideally they can be designed to become specialized cells. These cells could become bone marrow cells that could be used to repair major organs and parts such as the brain, spinal cord and the heart. Stem cell research is an ongoing political issue.[7] The Coalition of Advancement of Medical Research may have the answer to this political concern that you read about in the news. Some groups state that stem cell research must not be allowed on the moral grounds that it is using a part of the fetus. They published a fact sheet on therapeutic cloning.

Scientists do a type of cloning everyday when they produce insulin in the lab. It can be used to track biological origins. SCNT or Somatic Cell Nuclear Transfer claims that when a patient's DNA is transplanted into an egg that is not fertilized with sperm, its result will be recognized by the body and thus not be rejected. Using this technique, fertilization does not occur and no human being is created nor reproduced.[8]

These areas could be lumped together under the more general term biotech. Their information restates the previous information in more detail. "Biotech is the use of the science of genetics, alteration of the genetic code by artificial means and is therefore different from the traditional selective breeding." Of course, one type of biotech is human cloning. It makes a duplicate of the genes that can be placed inside a human egg. A duplicate or a cloned twin would be the result. Biotech would not make an identical twin but one that has unique genes. Unfortunately this confusion can give biotech negative images.

As stated earlier, stem cells can be included here with biotech. They will eventually provide treatment for many diseases and problems that we cannot cure at this time. It is possible that in time, the treatment may not cost very much. Stem cell can divide and reproduce rapidly so that they can produce specialized cells. Unfortunately stem cells come from embryos that can only be obtained illegally, or through a lot of red tape and paperwork involving special licenses. In addition, they are difficult to grow since they are often unstable. They may cause immune reactions when transplanted unless a lot of medications are prescribed. [9]

Cloning is one answer. The somatic cell nuclear transfer is one method. Somatic cells are the body cells. This is the method that was used to clone the sheep Dolly in 1997 by Scottish scientists. Scientists take a donor egg and remove the nucleus. A cell with DNA is removed from the animal or person to be cloned and fused with the egg without its nucleus using electricity. The resulting embryo is than implanted through in vitro fertilization into the surrogate mother. If the process is successful, the new baby will be a clone of the subject whose DNA was used.[10] This new embryo can be born normally but may result in malformations and premature ageing. This occurred in the sheep Dolly. Theoretically cloned cells should be compatible but the practice is expensive.

New research has shown that when embryonic stem cells are born that they are not as reliable as was once thought since most of the genetic memory has been turned off. The question is: Can the silent genes be reactivated a few at a time rather than all being activated into a clone? Jonathan Slack came up with a solution in the form of a chemical that mimics the chemicals in the embryo so that the genes can be awoken. [11] His interests are fascinating. They include "regeneration: understanding molecule mechanisms, understanding the regrowth of missing parts in cases where this exists in nature, and devising methods for provoking regeneration in cases where it is not."[12] In 2001 rules were passed in Britain to allow cloning of human embryos. These clones would be used to combat diseases such as Alzheimer's and Parkinson's. Stem cells could be used to replace certain parts of the human body. Therapeutic cloning would most likely be developed first so that it could be used to help sick people.[13]

Science fiction writers have been fascinated with genetic engineering or manipulation and cloning. The science fiction of today may be the science of tomorrow. As a personal note, at the 1964-65 World's Fair in New York, I was amazed at some of the technology that I saw then, but today we have palm size cell phones and computers. This was science fiction at the time. As recent as ten years ago the phones that people carried were much

larger. Large VCR players got smaller, with the DVD players following the same path. We have seen examples of what was once science fiction, become science facts all around us.

Therefore when you ask high school students about genetic engineering, some may mention the cloned sheep, Dolly. They think that it is fascinating that a duplicate can be made from the original. They are not familiar with the terms though until they are explained to them. They are usually interested in anything visual that has a lot of special effects (or unfortunately violence). I think using science fiction to help teach genetics would be an advantage since it is another avenue that they can explore which does not seem like learning.

The three sources explored in this unit are *Brave New World* by Aldous Huxley, *Beyond the Horizon* by Robert A. Heinlein and the 1997 film *Gattica*, which has recently been re-released.

Andrew Niccol was born in New Zealand in 1964 and began his career in London. He Began writing commercials but moved to Los Angeles to make longer films. Often his films have artificial realities. He is perhaps more known more for Jim Carrey's rendition in *The Truman Show* in 1988 than for *Gattaca* in 1997.[14] In an excerpt from October of 2005, it was written that *Gattaca* was the best film ever about brothers and their relationship. It explored the relationship between two brothers who were very different. One was considered genetically superior to the other. It related their trials and tribulations. Niccol created situations where people did things to other people but in real life that concept is a fantasy.[15]

Gattaca was written and directed by Andrew Niccol. I refer to a movie review written by Chris Jones in 2000 that says that the film is about the perfect world whose people have healthier lives through genetic manipulation. They can be given certain skills in their embryonic stage through engineering that can make them great in music or have impressive math skills. Major health problems can be eliminated at this time such as poor eyesight or a heart condition. The only problem with this perfect human is that it comes with a high price tag. It is okay for the rich but the poor could not afford it. The story is about a child who is not born with special abilities. He aspires to do more than his genes allow him to do. He dreams about space travel. He "defies the odds and proves that we are all more than the sum of our parts." Vincent, the main character, is one of the last to be conceived in by natural fertilization. Unfortunately he was born with a heart defect that suggested he would not live past his thirties. Several doors of opportunity are closed to him because of his heart problem. He stole the identity of another (Jerome) who does not have the genetic defect. He constantly uses "skin flakes, eyelashes, urine, pinpricks of blood-all the substances used for DNA testing" from Jerome so that he can get into the space program like he wanted.

It should be pointed out that the science seems a bit shaky: to use these samples as viable ones for DNA testing is highly unlikely and difficult. The eyelashes would have to be still attached to their follicles and there are not that many DNA parts in urine. The film

does not have any flashy special effects but deals rather with the human relationship that derives from one who wants to succeed and drink himself into oblivion as a challenge since he was perfect. Vincent had to be constantly on guard so that he had parts of Jerome's DNA that he can scatter. The reason you want to stay until the end is that you want to watch and see if he makes a false move which will reveal Vincent's true identity. This film was originally known as "The Eighth Day." This title was based on the biblical theme that God created the earth in six days and on the seventh day he rested. The Eighth Day implies that man tampered with what God had made. The center in the movie is called by this name.

An interesting comment in the review is by Dr. Athena Andreadia, a biologist who wrote *To Seek out New Life: the Biology of Star Trek*, who predicted that the Human Genome Project would be finished in the early 21st century. Currently there are several new articles about what genes have been discovered in the Human Genome Project. [16]

The letters in *Gattaca* refer to the four DNA nucleotides, the main nitrogen bases that will be discussed later in the classroom activity section. This film covers several different areas such as the social-emotional learning that deals with breaking out of a common mold and the issue of alcohol abuse. Questions arise about individuals' free will and desires that confront the destiny encoded in their designed genes. It also touches on the moral-ethical issues of respect and fairness. It deals with fertilized eggs that are selected and altered for various traits such as intelligence, appearance, strength and resistance to disease. This theme is similar to those presented in *Brave New World* and *Beyond This Horizon* that will be discussed next. *Gattaca* also refers to "faith babies", children born to parents naturally where the male sperm and female ovum are fertilized between a couple through natural means, or helped along by scientific methods such as in vitro fertilization.[17]

Brave New World, written by Aldous Huxley, is also used in this unit. Huxley was an English writer whose life span was from 1894 to 1963. His father was a writer and professional herbalist while his grandfather Thomas was a 19th century English Naturalist. His brother was a well-known biologist. Aldous suffered from the illness keratitis punctuate as a teenager and it left him almost blind for a few years. When his sight partially returned he studied English literature at Oxford. His sight had improved but was not good enough to read a lecture without difficulty. He wrote many books but he was condemned due to his free-thinking and sexual discussions in his books.

The book, though, helped to form the dystopian vision of the future where conditioning and control dominates the human spirit.[18] One theme of his book is about a carefree life style. All problems have been eliminated and everybody is "happy due to government-provided stimulation." This has been achieved by eliminating the things that give humans their identity such as "family, culture, art, literature, science, religion." It is a society whose pleasure comes from sex that is promiscuous and extensive drug use to escape anything that is not pleasant. Menial jobs are bred into humans who are similar, and who become Alphas, Betas, Deltas and Epsilons categories, depending upon the function that they do. All wear similar clothing and are very happy with what they do

since they are conditioned for that particular discipline using Pavlovian conditioning responses. (Ivan Pavlov was a Russian scientist who noticed that his dogs salivated in the presence of their dog feeder as well as dog meat powder. He tested his hypothesis by initially ringing a bell to call the dogs to eat. Eventually the dogs responded to just the ringing of the bell and not just the food. He coined this a conditioned response.)[19]

A character in this book called a "savage" is a Native American Indian young boy, who is brought to this perfect world but does not understand it and cannot enjoy it. The "savage" grew up in a world naturally, without drugs to help him with his daily problems. He had trouble understanding how anyone could just put problems away in their subconscious by taking a pill to forget and be happy. His mother had come from this perfect world but lived in the wilderness until rescued, and she was quite happy to return to the modern society. Unfortunately, she did not have access to the drugs and other medical benefits of the perfect society while she lived outside the city, and had aged and gotten fat. She was looked upon with loathing since she was not perfect like everyone else. Still another young male character, one who thought outside the box, wanted to exploit her son so that he would be accepted by his peers, instead of being viewed as strange and ridiculed. The book develops this theme of how the main characters deal with different problems by escaping or trying to find answers to their dilemmas.

There are several objectives about which the students will need to be made aware if they are given this book to read. The objectives I chose would be those that make connections between that which is happening at present times in relationship to behavior, and those that deal with economics and science in Huxley's novel. The other area would be to "understand the concepts of eugenics and clonings and the ethics debate they raise."[20] *Brave New World* is a text that uses technology. We know that many students are fascinated with technology. They often pick up something in the science lab or try to figure out how something works. (As a result of this fascination teachers are faced with the day-to-day problem of cell phones or ipods.) But students can be asked to think and to write about how they use technology, to compare what they think to those ideas in the novel, to analyze how technology is used and described and finally to reexamine their use of their own technology in relationship to the text.[21]

Another work, Robert A. Heinlein's *Beyond This Horizon* has similar themes but is a bit easier to read. He was born in Missouri and lived from 1907 to 1988. His interest in science fiction started as soon as he could read. He started submitting stories to "Astounding Science Fiction" which were edited by John W. Campbell. His career took off at that time. Heinlein's science fiction presented a newer approach to science fiction by making the future seem more possible.[22] In 1948 he wrote *Beyond This Horizon*.

The main character is very intelligent and is considered one of the leading thinkers of the society. He has been bred to be super-intelligent and has all the designer genes to make him perfect. But then again, he is dissatisfied with his life in general and is constantly seeking new ways to handle situations. He lives in the perfect society where all physical diseases have been genetically bred out of the main population. The times have strange concepts of dealing with polite society and following certain protocols.

Objectives

The subject area of genetics is difficult for many to understand. The students have a hard time remembering the terms and the concepts behind principles of genetics. The objectives are to relate genetics to something that the students will find interesting. Many students are visually-oriented today and some possess a lot of physical manipulative skills. Sharing these books and movie with the students can help them see a different approach to genetics. Other books and movies can be used to supplement this unit and bring students to view science through different medias (rather than the "I *hate* Science" comments that are often heard). They can make connection between these books and their current lives and how fast technology is changing. It seems almost each day brings the news and more information about genetic engineering. It is especially related to food modification so that more, larger, and better foods can be grown and distributed. They can take online short quizzes about their knowledge of technology and broaden their thinking so that they can think "outside the box." They can think about their own beliefs and start thinking about what they will do when they are old enough to participate in voting and making decisions in their lives. It also opens up the area of critical thinking and "what if..." thinking, which is important since students often have a hard time writing about different topics that are not familiar to them.

Strategies

This unit aims to help the students with their thinking and writing skills. Some of these strategies were mentioned above, and will be developed more in the classroom section. Today some students have a difficult time expressing in writing what their opinions are. They have a hard time summarizing an article and giving their opinion about it. They often want to know whether or not what they are writing down is right or wrong. Even when they are told to write whatever they want, they still need the reassurance that what they are writing down is correct.

At some points, they will be required to work in pairs and sometimes by themselves. Students can develop better collaborative skills by having them work more together by doing such techniques as "jigsaw." Teachers can use this to cover large subject areas. At times, certain areas of the books can be assigned to different groups in the class, and the students can be asked to write about them or discuss them. But the idea behind this unit is to help the students develop their science thinking so that they appreciate as well as understand what is happening when they read and study science topics.

Classroom Activities

In this unit, the teacher can use either parts or the entire module. The books may be read and a summary written up as a term project. According to the School District Core Curriculum, genetics is covered at the end of the second marking period and into the third marking period according to the Timeline. (Standards are included in the Appendix.)

We will utilize a few chapters in the current biology book used in the School District of Philadelphia. It is the 2004 edition of *Holt's Biology*. The same or similar chapters are found in any biology book written since year 2000 and in some even earlier. They deal with genetics and gene technology.

Genetics is the study of the DNA code that differentiates one human from another. It is the same for all living flora and fauna. Humans have 23 pairs of chromosomes or 46 altogether. The fruit fly has only 4 and is used extensively in classes to study genetics. Each chromosome is made up of DNA that determines the physical and chemical nature of living organisms. DNA is a double helix that is made up of the sugar deoxyribonucleic acid, phosphate, double and triple bonds. There are 4 nitrogen bases that combine in certain ways to determine different traits. The bases are adenine, guanine, cytosine and thymine. They follow specific pair basing guidelines. If the guidelines are not followed, a mutation or abnormality may result. This brief explanation is at its simplest level, and can be expounded upon and found in any biology or genetics books.

1. This module can be used for high school biology and/or anatomy students. In preparation I would want my students to write a page about what they start off knowing about genetics. Once they have written about it, they should research it and write two pages about what they have found. Their research should include the origin of the word "genetics" and what it means. They will come across information about Gregor Mendel who is considered the "Father of Genetics."

2.Their next "free write" will be about gene technology. Again they write one page about what they know. (Students are usually clueless about this until you give them some ideas such as cloning and the sheep Dolly.) Again, they must do an assignment involving research on the Internet about gene technology of about two pages in length. Textbooks have information about these topics, but having the students do a more up-to-the-minute research on these topics is desirable since the data changes so much in today's society. When they do their research, also have them include their articles so that you can accumulate a collection of them. Once there are enough, choose any 10 of them and distribute them to groups of three. When they have finished and summarized their articles, have each group write 5-10 facts about their articles and post them around the room. Have the groups wander around the room and write down the facts for the different articles. Each group can then share the information with the rest of the class.

The students should certain that they have information about the following questions:

1. What was the article about?
2. Who were the people discussed in the article?
3. What professions were they in?
4. Describe what they did?
5. Where was the article written?
6. When did the events described occur?
7. What different examples if any were given?

At this point, each student should have information about ten different articles in addition to the one that they found and wrote about initially. Have them make up 10 questions from the information that they have gathered, and have each of their partners answer their questions so that each student answers 20 questions all together in sentences.

3. Later, the teacher can read excerpts from *Brave New World* and *Beyond This Horizon*. Each section read will be 4 pages long, and only one book would be read every other day. The students would listen and try to write short summaries on what was read. The teacher can also explain each section as it is read so that it is easier for the students to take down the notes. Then,

a. Each student will research Aldous Huxley and Robert A. Heinlein, and write one page about each author.

b. Next, they will randomly choose one book or the other from a box full of two different symbols each representing one of the books. Their term project will be to read their book and write a three-page general book report about their book. The report will briefly summarize what happened in the book. The fourth page will be about any scientific information that was provided in the book.

c. Finally, they will choose any 2 individuals or groups from the book, and write about them using information from the book, as well as outside information from the Internet.

4. There are certain objectives mentioned earlier that that I wanted the students to follow. These were taken from the lesson plans titled "*An Incredible Journal: Exploring Brave New World*." (I have used certain parts of these lesson plans so that they deal with my module.) Students should research information about Henry Ford, Ivan Pavlov and B. F. Skinner. Sample questions are given from the lesson plans about technology. I would like to use their survey and their rubric.[23]

At this point, Mathematics can be introduced by having the students figure out the ratios of how many students agreed and disagreed on all of the 12 points in the survey in their class and in the total number of students in all biology classes.[24] In the Appendix

you will find a questionnaire (from North Montco Technical Career Center) for "Prediction/Writing Journal" which can be used for both books. The "Key Word Notes" can be adapted for key phrases for every 50 pages sections instead of paragraphs. Finally the "reflection Journal (after reading)" questionnaire can be utilized. All three of these can be used for both books.

5. We will use the Face/Head Variation Activity from the Applied Biology/Chemistry Program written in 1991. [25] This will be shared between two students. This activity and more up-to-date versions can be found in any biology curriculum:

Each student would flip a coin to determine which characteristic would show up for their offspring. The different areas are:

* Sex
* Face shape
* Skin color
* Chin shape
* Cleft
* Eyelashes length
* Mouth-size
* Protruding lower lip
* Hair type and color
* Widow's peak
* Eyebrow's shape and color
* Eyes-Distance apart
* Eyes shape, size, slantedness
* Eye color
* Lips
* Dimples

They would than do the same activity but instead of flipping a coin, they would design their offspring by choosing their different features. Finally they would compare the two individuals and write an essay about which offspring they prefer and why.

6.Another lesson plan that will be found in the appendix will help the students understand the issues that deal with the ethics of genetic engineering. as well as different terms and concepts that are often found in genetic engineering. [26] (This can be printed but not saved unless you want to join Discovery Education). There is also a video that can be accessed with questions that the students can answer. Another source that the students can go to, or the teacher can access, gives a short quiz on what the students might know about genetics.[27] This short quiz is "Cloning or Not?" If they get their answers wrong they can easily find out why they were wrong.

7. Afterwards, the movie *Gattaca* will be viewed in class in 30 minute segments. The three reflection pages listed above also would be used for this section. They can be adapted for the movie.

Finally, each student would compare the movie to whatever book they read. They would compare and contrast. They will be asked to tell which one they like the best, and why. They could look at how it relates to their current thinking about how they look at others who are different.

Materials

These are information formats from the North Montco Technical Career Center that can be used and adapted. Leave space for the students to write. As an option, you can add such things as “answer in full sentences.”

Prediction/Writing Journal

Name Session Date
Article Name
Attach this sheet to a copy of the reading assignment.

Before Reading:

1. What would you predict this reading to be about?
2. What do you already know about this topic?

After Reading:

3. What do you think the author wants you to believe after reading this article or passage?
4. Write a sentence or two about what you have learned from the reading.
5. How does this reading relate to my career choice?

Key Word Notes

Directions:

1. For each section, write 3 to 5 key phrases that will help you remember the most important information in that section.
2. After sharing the information, put aside the reading and write a summary at the bottom of the sheet, using all the key words.

You can put in boxes for the students to write in designating paragraphs 1-3, 4-5, 6-7 and 8-9 or whatever parameters you want to use. At the bottom you would have a section for Summary (write without reading):

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Reflection Journal (after reading)

Name Date

After reading the passage, reflect on your progress, and answer the following questions:

1. What was the main idea of the passage?
2. How did the main idea compare to your before reading prediction?
3. Summarize at least three ideas from the passage you have read?
4. What have you learned from this reading that will help you in your career training?

Bibliography
Teacher Resources List for Genetics Through the Eyes of Tomorrow

1. Brave New World . Aldous Huxley (orig.1932), First Perennial Classics ed., HarperCollins Publishers, New York, 1998. Social commentary about a future society in which technology has engineered a "perfect" human existence.

2. Beyond This Horizon . Robert A. Heinlein, (orig. 1948) Baen Books, 2002. Applied genetic science has given many humans beautiful bodies, long lifespans, superior talents, but occasional unhappiness.
3. http://science.how stuffworks.com/human-cloning.htm about Bonsor, Kevin
4. http://www.teachwithmovies.org/guides/gattaca.html
5. http://www.globalchange.com/books/genesinyto.htm about Patrick Dixon
6. http://en.wikipedia.org/wiki/Science_fiction
7. http://learngenetics.utah.edu/units/cloning/
8. http://www.readwritethink.org/lessons/lesson_view.asp?is=323
9. http://www.teachersnetwork.org/readysetteach/janka/janka.htm about An Incredible Journey
10. http://school.discoveryeducation.com/lessonplans/geneticengineering
11. Read excerpts from Wikipedia about Robert Heinlein, Aldous Huxley and the 2 books and the movie Gattaca
12. Movie *Gattaca.* Columbia Pictures, 1997. A future society based on eugenics, where individual lives are regulated by genetic classifications.

Student's Resources List

1. Brave New World by Aldous Huxley
2. Beyond This Horizon by Robert A. Heinlein
3. www.bcps.org/offices/lis/models/splice/genestudentresources.htm
4. forums.studentdoctor.net.showtheread.php?t=517531
5. www3.iptv.org/exploremore/genetics
6. www.bcps.org/offices/lis/models/splice/cloningstudentresources.htm
7. www.ornl.gov/sci/teachresources/Human_ Genome/elsi/cloning.shtml
8. ursamajor.hartnet.org/chow/integrate/cloning.htm
9. www.glencoe.com/sec/science/webquest/content/cloningt.shtml
10. movie *Gattaca*

Appendix

Standards Addessed

The standard addressed is to understand what the principles of heredity are about, and their related concepts.

The student will learn the different terms related to heredity and the properties of DNA.

They will learn about the new developments in genetic engineering.

They will work on their comprehension, listening and writing skills.

This module is designed for use in Biology 1 or 2 and/or Anatomy and Physiology. I would use it as a term project or two. It could also be used in conjunction with the units on genetics and genetic engineering.

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[1] http://www.the freedictionary.com/cloning
[2] http://learngenetics.utah.edu/units/cloning/
[3] http://encarta.msm.com/dictionary_1861595733/cell.html
[4] http://www.the freedictionary.com/futurist
[5] http://www.globalchange.com/PatrickDixon.official site
[6] http://www.globalchange.com/clone_index.htm
[7] www.globalchange.com/clonch.htm-Human cloning...
[8] http://www.camadvocacy.org/resources/SCNT_FAQs.htm
[9] www.globalchange.com/biotech.htm-Biotech:what is Biotech?
[10] Bonsor,Kevin. "How Human Cloning Will Work"02 April 2007. HowStuffWorks.com <http://science.how stuffworks.com/human-cloning.htm>
[11] www.globalchange.com/clonch.htm-Human cloning...
[12] www.bath.ac.uk/crm/crm_people.html.Centre for Regenerative Medicare. University of Bath
[13] http://www.how stuff works.com/framed.htm?parent=hman-cloning.htm&url=http://www.humancloning.org
[14] http://us.imdb.com/nam/nm0629272
[15] http://www.the stopbutton.com/2005/10/13/gattaca-1997
[16] http://www.chris jones.suite/01.com/daily.cfml2000-12-08
[17] http://www.teachwithmovies.org/guides/gattaca.html
[18] http://en.wikipedia.org/wiki/Aldous_Huxley
[19] http://en.wikipedia.org/wiki/Classical_conditioning#Pavlov.27s_experiment
[20] http://www.teachersnetwork.org/readysetteach/janka/janka.htm.
[21] http://www.teachersnetwork.org.readysetteach/janka/janka.htm An Incredible Journey: Exploring Brave New Worlds
[22] http://www.bookrags.com/biography/robert-anson-heinlein-db/2.html
[23] http://www.teachersnetwork.org/readysetteach/janka/janka.htm.An Incredible Journey
[24] http://www.readthink.org/lessons/lesson_view.asp?id=323

[25] Harless, William , Continuity of Life, copyright 1991 by the center for Occupational Research and Development, Waco, Texas

[26] http://school.discoveryeducation.com/lessonplans/programs/geneticengineering

[27] http;?learngenetics.utah.edu./unit/cloning/